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2  
3 SPECIFICATION  
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5 METHOD AND APPARATUS FOR SEPARATING IMPURITIES FROM A LIQUID  
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7 BACKGROUND OF THE INVENTION  
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9 Application claims the priority of Provisional  
10 Application no. 60/222,627 filed August 3, 2000 for this  
11 application.  
12

13 1. Field of the Invention.  
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15 This invention relates to a method and apparatus for  
16 removing impurities from a liquid and more particularly to  
17 such a method and apparatus in which such impurities are  
18 removed by distilling the liquid to a vapor and feeding the  
19 vapor through arrays of rotating semi-permeable screens.  
20

21 2. Description of the Related Art.  
22

Thermal separation of impurities(or non-desired components) from a liquid generally involves separation of liquids with different vapor pressures or boiling points in a distillator. The upward vapor stream in the tall separation columns of the distillator is in continuous contact with the liquid phase so that efficient mass transfer occurs. The vapor

1 stream is isolated by exposure to a condenser and the  
2 counter-current downward flowing liquid is reheated to effect  
3 vaporization at the bottom of the column by means of  
4 re-boiler. To expose the vapor stream to large surfaces of the  
5 liquid phase, a cylindrical column of plates, trays or  
6 packings are used. Distillation involves an equilibrium stage  
7 concept wherein separation is effected by the addition or  
8 withdrawal of heat. The distillation process may be  
9 isothermal(i.e.with constant temperature but changing volume  
10 and pressure) or adiabatic(i.e. with no loss of heat.

11 For the separation of liquids with close boiling points  
12 or systems with low relative volatilities, enhanced separation  
13 methods have been developed which rely on additional  
14 mechanisms to further modify the vapor-liquid equilibrium.  
15 These techniques may involve azeotrope distillation, pressure  
16 swing distillation, extractive distillation, salt distillation  
17 or reactive distillation. Each of these approaches relies on  
18 the addition of differing liquids or solids or an outright  
19 chemical reaction. For the separation of complex mixtures,  
20 tall separation columns are used to provide for the efficient  
21 refluxing and stripping of the liquids to yield a purified  
22 vapor which is a fraction of a given compound.

1           For the separation of liquids wherein the relative  
2 volatility between the components is very large, or when  
3 partial separation is only intended, a single stage flash  
4 distillation process may be used. This process could be  
5 isothermal or adiabatic. Some higher boiling components of a  
6 mixture may exhibit volatility with aqueous steam and allow  
7 for differential distillation using the steam stripping  
8 technique.

9           Distillation is widely practiced in the commercial  
10 separation and purification of ingredients in petroleum  
11 crudes, plant derived oils and fats, solvents, essential oils,  
12 the cleaning of natural gas, methanol, ethanol, large scale  
13 synthetic chemical compounds and other substances. In the  
14 course of distillation in columns having multiple liquid  
15 stages, the vapor passing through the liquid has a tendency  
16 for small droplets of liquid to be entrained in the ascending  
17 vapor stream. This tendency increases as the upward velocity  
18 of the vapor stream is increased. Further the vapors of many  
19 liquid compounds contain molecular aggregates that may be  
20 formed by Van der Waals forces, associations caused by  
21 quadrupole moments or inducted polarity due to the presence of  
22

1 double or triple bonds in the respective molecules or ionic  
2 attractions.

3 The system and method of the present invention provides  
4 an improvement over the aforementioned prior art distillation  
5 techniques in providing enhanced separation of impurities from  
6 liquids that do not involve variations in temperature and  
7 pressure to achieve the desired end result. Further the system  
8 and method of the present invention is capable of separating  
9 out molecular ingredients that have small boiling point  
10 differences with the desired output liquid.

11 In my patent no. 5,695,130 issued December 9, 1997, a  
12 grinding system is described in which rotating screens with  
13 wide mesh openings are first used to comminute particulate  
14 material through spiral vortexes and such comminuted material  
15 is then fed to circular vortexes formed between rotating discs  
16 and stationary plates where the final grinding of the  
17 particulate material is accomplished and the final comminuted  
18 material is separated from the gas streams by centrifugal  
19 fans.

20 In my patent no. 6,044,977 issued April 4, 2000, a  
21 system and method is described utilizing an array of  
22 semi-permeable rotating screens which generate vortex zones

1 through which gas is passed to effectively remove micro  
2 particles therefrom.

3 The present invention is directed to the use of such  
4 rotating screens to effectively separate out impurities from a  
5 vapor stream. Further, in the present invention by utilizing  
6 screens that rotate at high speeds and generate large  
7 centrifugal gravity forces, elements of different molecular  
8 weight or geometrical configuration can be sorted out.

#### 9 SUMMARY OF THE INVENTION

10 In the system and method of the present invention a  
11 liquid with components contained therein to be separated out  
12 is first distilled to produce a vapor. The vapor is fed into a  
13 first container having an array of semipermeable screens  
14 therein, such screens being rotated at a velocity of  
15 3,000-10,000 rpm. Vertical spiral vortexes generated by the  
16 screens separates out impurities from the vapor and splits  
17 molecular assemblies therefrom. From the first container, the  
18 vapor is fed to a second narrower diameter container which has  
19 an array of semi-permeable screens. The screens of this second  
20 container are rotated at high velocity (6000-100,000rpm).  
21 Here, horizontal centrifugal separation is achieved with  
22 separation of molecular species in the vapor stream. The

1 purified vapor is finally fed to a condenser which restores it  
2 to liquid form.

3 It is therefore an object of this invention to provide  
4 a system and method for separating out impurities from a  
5 liquid;

6 It is a further object of this invention to provide a  
7 more efficient and simpler system and method for separating  
8 impurities from a liquid;

9 It is a still further object of this invention to  
10 provide a system and method for separation out of molecular  
11 species from a liquid;

12 Other objects of the invention will become apparent in  
13 view of the following description taken in connection with the  
14 accompanying drawings.

#### 15 DESCRIPTION OF THE DRAWINGS

16 FIG. 1 is a schematic drawing illustrating the first  
17 and second containes and rotating screens for separating out  
18 impurities in the preferred embodiment of the invention;

19 FIG 2 is a to plan view of one of the rotating screens  
20 of the preferred embodiment; and

21 FIG 3 is a schematic drawing illustrating the operation  
22 of the preferred embodiment.

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3 DETAILED DESCRIPTION OF THE INVENTION  
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5 Referring to the drawings, a preferred embodiment of  
6 the invention is illustrated.

7 Liquid to be purified is placed in boiler 10, vapor and  
8 liquid from boiler 10 being fed to distillation column 13  
9 which has fractioning plates 13a therein. Distillation column  
10 13 is a conventional such column which converts all of the  
11 liquid to vapor.

12 The vapor from the distillation column is transferred  
13 through line 12, by the action of an inert gas drive in line  
14 18, to the bottom of container 19 in which an array of  
15 rotatable semi-permeable screens 11 is mounted. Separated out  
16 vapor 30 is fed out from the bottom of container 19 to boiler  
17 10 for recycling. The screens are rotatably driven by means of  
18 motor 21 at a velocity of 3000-10,000 rpm. Vertical spiral  
19 vortices are generated by virtue of the rotation of the  
20 screens, these vortices acting on the vapor stream to separate  
21 impurities therefrom. The partially purified vapor is fed by  
22 the action of an inert gas drive 29 through lines 14 to the  
bottom of second container 15 for further purification.

1 Material separated out is fed to the bottom of container 15.

2 One of the semipermeable screens is illustrated in FIG  
3 2. The screens have a steel holding frame 11a in which the  
4 screen 11b is mounted. Screen 11b may be in the range of 2.5-60  
5 mesh and preferably 4-10 mesh. The screens are rotatably  
6 driven by motor 21 at 3000-10,000 rpm.

7 Referring to FIG 3, the separation operation of the  
8 rotating semi-permeable screens is illustrated. The vapor  
9 stream when it strikes the underside of the bottom rotating  
10 screen 11 is de-misted with the vapor stream itself passing  
11 through the screen. The high speed rotating screens generate  
12 centrifugal gravity by virtue of the large horizontal velocity  
13 vector which separates the varying molecular species in the  
14 upward vapor stream. The vertical velocity vector results in  
15 the generation of vertical spiral vortexes in the upwardly  
16 traveling vapor stream. The vertical spiral vortexes induce  
17 separation in the vapor stream by the addition of high kinetic  
18 energy to such vapor which is thereafter subjected to a  
19 centrifugal sorting action by the large horizontal vector. The  
20 portion of the vapor stream 30 which is separated out by the  
21 large horizontal centrifugal forces is dropped by gravity to  
22 the bottom exit 31 of the container 19 (See FIG 1) and fed to



1 boiler 10 for recycling.

2 Referring to FIG 1, the vapor stream is outputted from  
3 container 19 through lines 14 by means of pressurized inert  
4 gas in line 29 and fed to the bottom of container 15.  
5 Container 15 has an array of semi-permeable screens 11 driven  
6 by motor 36, similar to that described in connection with  
7 container 19. The container and its driven screens differ from  
8 that of container 19 in that the diameter of container 15 is  
9 narrower and the screens are driven at the much higher speed  
10 of 6,000-100,000 rpm. The high centrifugal forces generated in  
11 container 15 represented by the high level horizontal vectors  
12 of the rotating screens acts to separate out molecular species  
13 in the vapor stream. The more volatile fraction which  
14 constitutes the purified vapor is exited from container 15  
15 through lines 17 and fed to condenser 37 for conversion to  
16 liquid form. The less volatile fractions accumulate on the  
17 container wall and are tapped from the bottom of the  
18 container.

19 While the invention has been described and illustrated  
20 in detail, it is to be clearly understood that this is  
21 intended by way of illustration and example only and not by  
22 way of limitation, the scope of the invention being limited

only by the terms of the following claims.

I claim: